Utilizing Organic Compounds and Planting Medium to Enhance the Growth Rate of *Vanda tricolor*

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Abstract. This study aims to investigate the reciprocal impact of Vitamin B1 and rice washing water usage, as well as the utilization of lumber + coconut husk + moss medium, to identify the most effective medium for expediting the growth of *Vanda tricolor* seedlings after acclimatization, as well as determining the optimal application method for Vitamin B1 or rice washing water to enhance their growth. This study is a field experiment that uses a complete factorial randomized block design, comprising 2 elements. The primary determinant is the medium composition, consisting of either lumber or a combination of lumber, coconut husk, and moss. The secondary component is the nutrient source, which can be water, vitamin B1, or rice-washing water. The research findings indicate that the growth of *Vanda tricolor* after acclimatization is influenced by both the kind of medium and nutritional source, specifically to disease attack parameters. Lumber is the preferred medium for promoting the growth of *Vanda tricolor* after it has adapted to the conditions on the slopes of Mount Merapi. Vitamin B1 is the suggested nutritional supply to enhance the growth of *Vanda tricolor* after it has adapted to the conditions on the slopes of Mount Merapi.

1 Introduction

Merapi orchids are a variety of orchids that specifically thrive on the slopes of Mount Merapi (7° 32,5′ South Latitude 110° 26,5′ East Longitude) in Yogyakarta, Indonesia. They are predominantly found on the South and Southwest sides of the mountain. Nevertheless, the recurrent volcanic eruptions of Mount Merapi since 2006 have resulted in the extinction of a minimum of 10 species of orchids native to the Merapi region. Consequently, the Ngudi Makmur farmer group focused their efforts on conserving the Merapi orchid and reintroducing it to its natural habitat on the slopes of Mount Merapi. The Ngudi Makmur Farmer Group receives help from the Mount Merapi National Park, which is dedicated to conserving orchid species in the Mount Merapi Area [1]. The Ngudi Makmur Farmers Group currently possesses three greenhouses dedicated to the preservation of Merapi

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orchids. These greenhouses employ conventional cultivation methods, specifically stem cuttings and seedlings. Nevertheless, this mode of proliferation necessitates a significant amount of time and yields a limited quantity of new seeds. Hence, contemporary propagation efforts that can yield substantial quantities of seeds within a relatively brief period offer a viable option for reintroducing the Merapi orchid to its native environment on the slopes of Mount Merapi.

Vanda tricolor is one of the Merapi orchids that has been protected by the Ngudi Makmur farmer group. The *Vanda tricolor* orchid exhibits a morphology characterized by a spherical, long, and robust stem, reaching a height of up to 2 meters. Its leaves are slightly curled and have a ribbon-like form. The *Vanda tricolor* orchid is characterized by three distinct flower colors: white with brown patches on the petals, and a purple labellum located in the centre of the petals [2]. *Vanda tricolor* is an epiphytic orchid that grows by attaching itself to the trunks of trees. The reintroduction of Merapi orchids to their native habitat is limited due to the scarcity of seeds obtained through conventional cultivation, which yields a tiny quantity of seeds or young plants over an extended duration. In addition to the limited number of new seeds acquired, the Ngudi Makmur farming group does not engage in thorough maintenance, particularly utilizing improvised planting materials made from lumber and fertilizing the farmed orchids. As a result, the growth of the plants is relatively slower.

In response to the issues presented by the leader of the Ngudi Makmur farmer group, it is imperative to devise a resolution that would enhance the cultivation of Merapi orchids, particularly *Vanda tricolor*, thereby facilitating the successful reintroduction of a greater number of orchids into their native environment. Thiamin (Vitamin B1) and rice washing water are compounds that can be utilized to promote the growth of *Vanda tricolor* orchids.

Vitamin B1 functions as a coenzyme [3] and a catalyst in metabolism [4], contributing to the plant growth process. Vitamin B1 is a crucial vitamin that promotes rapid cell division in plants. Vitamin B1 is involved in plant metabolism and facilitates plants in adjusting to new settings when they are relocated [5]. According to a study, thiamin has the greatest ability to promote the growth of *Dendrobium laxiflorum* orchid seeds, surpassing niacin and pyridoxine [6]. Applying Vitamin B1 at a concentration of 3ml/L yields optimal outcomes in terms of leaf length and stem height for Dendrobium orchid seedlings [5].

The rice washing water is rich in nutrients, including 80% Vitamin B1, 70% Vitamin B3, 90% Vitamin B6, 50% Manganese, 50% Phosphorus, and 60% Iron [7]. The vitamin content included in rice washing water plays a crucial role in promoting the growth of roots. Based on [8], providing 100% rice washing water yielded the most favorable outcomes in promoting growth in acclimatized *Vanda sanderiana* orchids. In addition to nutrients, the medium can also have an impact on the growth of *Vanda tricolor* following acclimatization. Research findings [9] indicate that the utilization of moss yields optimal growth for Moon orchids. Meanwhile, it was suggested that the combination of red brick pieces and fresh coconut husk is the most suitable medium for acclimatizing hybrid Dendrobium orchids. The utilization of coconut husk as a growth medium result in the most significant augmentation in the number of leaves. Lumber was employed as a medium in this investigation. Based on [11], the procedure involves treating a combination of fern, charcoal, and coconut husk media with Growmore® fertilizer. The concentration of 1.5 g/L of water yielded optimal outcomes for the variables of shoot number plant height, and number of leaves. Based on [12], the optimal treatment for enhancing the percentage of life, number of leaves, leaf length, leaf width, leaf chlorophyll content, and number of stomata in *Vanda tricolor* orchids during the acclimation stage is a combination of coconut husk and moss in a ratio of 2:1.

This study aims to investigate the causality of the utilization of Vitamin B1 and rice washing water, as well as the utilization of coconut husk+ moss and wood medium, on the

growth of *Vanda tricolor* seedlings after acclimatization. The other objective is to identify the most effective medium for promoting the growth of *Vanda tricolor* after acclimatization and to determine the optimal application method for Vitamin B1 or rice washing water to enhance their growth. The findings of this study are valuable for expediting the growth of the *Vanda tricolor* orchid following acclimatization, hence accelerating its reintegration into its native habitat.

2 Methodology

The study was conducted on the slopes of Mount Merapi, namely in Turgo Village, Pakem District, Sleman Regency, Yogyakarta. The geographical coordinates of the research site are 7° 35' 12.1" South Latitude and 110° 25' 27.8" East Longitude. The study utilized *Vanda tricolor* orchid plantlets that had undergone acclimatization, together with coconut fiber, moss, ferns, Vitamin B1, and rice washing water as the ingredients and planting media. The instruments used are a ruler, stationery, wire, raffia, hand sprayer, and scissors. The utilized research methodology was experimental research, employing a complete factorial randomized block design, comprising 2 elements. The first determinant is the medium composition, which can be either lumber or a combination of lumber, coconut husk, and moss. The secondary factor is the nutritional source, which includes water, vitamin B1 and rice washing water. Therefore, there are a total of six treatment combinations. Each treatment was replicated 4 times, resulting in a total of 24 experimental units.

2.1. Sterilization of Planting Medium

The sterilization of the planting medium, specifically the moss and coconut husk, is accomplished by immersing the medium in a solution containing bactericides and fungicides for 15 minutes, followed by drying. Subsequently, the two media were subjected to sterilization using an autoclave at a temperature of 121°C, at a pressure of 1 atmosphere, for 20 minutes.

2.2. Orchid Planting

Orchids can be planted on a lumber medium or a combination of lumber, coconut husk and moss medium by securely attaching the orchid to the chosen medium. Subsequently, the orchid is treated by irrigating it with a nutrient solution specific to the treatment every week. The spray volume utilized is 5 milliliters, and the watering occurs once each week. The nutritional sources used in the experiment included water (as a control), Vitamin B1 at a concentration of 3 ml/L, and rice washing water at a concentration of 100% (200 grams of rice rinsed with 200 ml of water).

2.3. Parameters Observed and Data Analysis

The parameters observed include the percentage of disease attacks, the percentage of pest attacks, the number of leaves, leaf length, leaf width, number of roots, root length and root diameter. The data obtained was then analyzed using an analysis of variance with an alpha level of 5%.

3 Results and Discussion

3.1 The survival rate of *Vanda tricolor* seedlings and the incidence of insect and disease attacks

The analysis of the influence of medium type and nutrition source on disease attacks on *Vanda tricolor* orchid seedlings revealed a significant interaction (Table 1). The type of medium and source of nutrients mutually influence the occurrence of disease attacks on *Vanda tricolor*. According to the results in Table 1, the lumber medium with water as the only nutrient supply had the highest percentage of disease assaults, accounting for 52.50%. Nevertheless, this treatment did not exhibit any significant variation compared to other treatments, except for the lumber medium treatment when supplemented with the nutritional supply of vitamin B1. Vitamin B1 enhances cell proliferation in the root meristem and mitigates the negative effects of stress during plant transplantation or repotting. Stress renders plants more vulnerable to diseases [13]. The study site is situated on the slopes of Mount Merapi, at an elevation of 1223 meters above sea level. The typical daily temperature ranges from 18 to 22 degrees Celsius. Meanwhile, the average daily humidity ranges from 65% to 92%. The plant is exposed to a humid atmosphere, which increases the moisture levels during the watering of *Vanda tricolor* seedlings. This high humidity makes the plant more vulnerable to disease, particularly fungal and bacterial infections. This outcome was anticipated by the sterilization of the planting media. However, due to the elevated humidity levels, a significant number of diseases emerged. In addition to the favorable microenvironmental conditions for the proliferation of fungus spores and bacteria, the physical characteristics of the planting medium, particularly moss and coconut husk, have a high water retention capacity, leading to an escalating humidity level in the surrounding area of *Vanda tricolor*. This leads to the creation of environmental conditions that are conducive to the proliferation of fungal and bacterial spores.

Table 1. Effect of medium type and nutrient source on the percentage of disease attacks on *Vanda tricolor* orchid seedlings (%) 8 weeks after planting.

Treatment	Water	Thiamine/B1 Vitamins	Rice washing water	Average
Lumber	52,50 a	6,25 b	21,25 ab	26,67
Lumber + coconut husk + moss	21,25 ab	33,75 ab	30,00 ab	28,33
Average	36,87	20,00	25,62	(+)

In addition to disease, *Vanda tricolor* seedlings are susceptible to pest infestations. However, the relationship between the type of medium and nutrient source treatment and insect attacks is independent of each other. The data shown in Figure 1 indicates that the type of media does not have a substantial impact on pest assaults on *Vanda tricolor* seedlings. The wood medium is susceptible to insect infestations compared to the medium consisting of lumber, coconut husk and moss. When orchid seeds are directly attached to lumber without any protective covering like moss or coconut husk, it increases the plant's vulnerability to pest infestations. Meanwhile, various sources of nutrition have an impact on pest infestations. Seedlings irrigated with rice washing water exhibit increased vulnerability to insect infestations. The application of rice washing water creates a wet and scented atmosphere for *Vanda tricolor* seedlings, which attracts pests and makes the plants vulnerable to pest attacks.

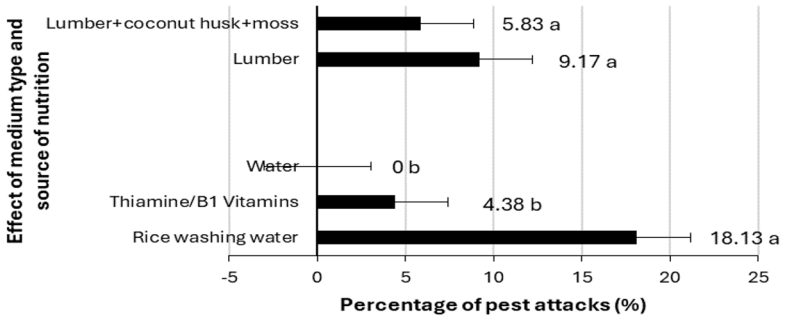

Fig. 1. Effect of medium type and nutrient source on the percentage of pest attacks on *Vanda tricolor* orchid seedlings 8 weeks after planting.

3.2 Leaf growth

The quantity of leaves directly affects plant development and yield as leaves serve as the primary site for plant photosynthesis and provide the necessary energy for growth [14]. The variance analysis results indicated that there was no significant interaction between the medium type and nutrition source to the number of leaves, leaf length, and leaf width of *Vanda tricolor* 8 weeks after planting. Figure 2 indicates that the kind of medium does not have a notable impact on the number of leaves, leaf length, or leaf width of *Vanda tricolor* after 8 weeks of planting. Nevertheless, the utilization of lumber as a medium promotes a more significant growth in both the number of leaves and leaf length, in contrast to the medium consisting of lumber, coconut husk, and moss. Orchids are plants that possess aerial roots, allowing them to thrive even when attached just to a lumber medium. This enables the plants to carry out metabolic processes by receiving CO_2 and other nutrients through their roots. The metabolism of *Vanda tricolor* leaf cells is adequate to facilitate cell elongation and division, increasing the quantity and length of leaves. In addition, the research area had a high level of humidity, which prevented the roots of the *Vanda tricolor* plant from drying up, while attached to a lumber medium.

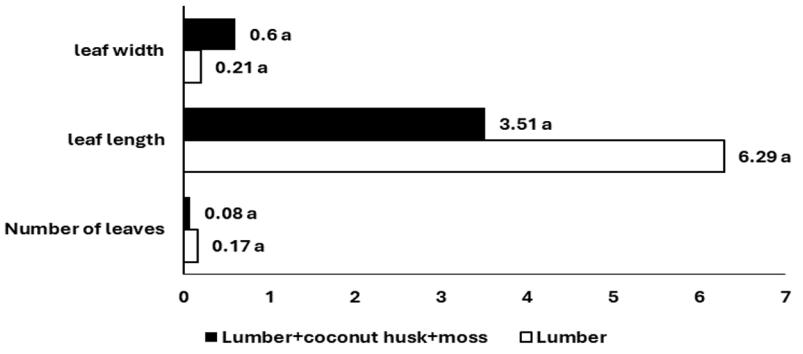

Fig.2. Effect of planting medium on leaf width, leaf length and number of leaves of *Vanda tricolor* seedlings 8 weeks after planting.

Figure 3 indicates that the nutritional source does not have a significant effect on the number of leaves, leaf length, and leaf width of *Vanda tricolor* 8 weeks after planting. Nevertheless, the utilization of thiamine or vitamin B1 tends to enhance the quantity of leaves and the length of leaves more effectively than water alone and rice washing water. Vitamin B1 enhances cell division and stimulates hormone activity in plants, promoting the formation of new cells. Additionally, it functions as a coenzyme in carbohydrate metabolism [6]. This subsequently promotes a rise in both the quantity and size of *Vanda tricolor* foliage. Vitamin B1 facilitates the synthesis of carbohydrates, proteins, and lipids that are essential for the growth and development of *Dendrobium* orchids [15]. Thiamin is involved in both abiotic and biotic stress processes in plants [16, 17, 18].

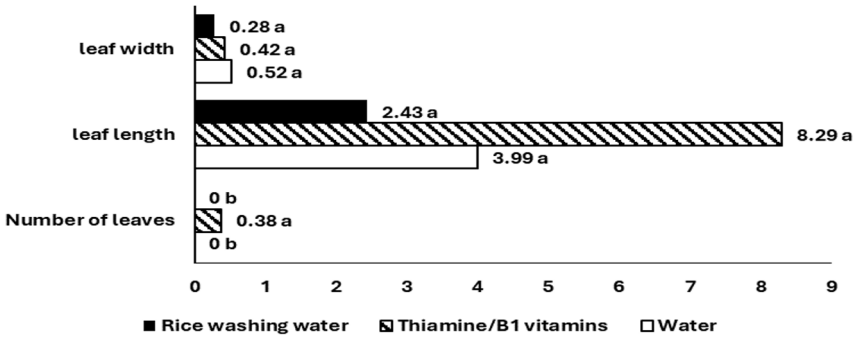

Fig. 3. Effect of nutritional sources on leaf width, leaf length and number of leaves of *Vanda tricolor* seedlings 8 weeks after planting.

Vitamin B1 catalyzes the breakdown of carbohydrates into adenosine triphosphate (ATP), a crucial source of energy for the growth of orchids. Orchids assimilate carbohydrates, specifically glucose, through the process of photosynthesis. Glucose is subsequently metabolized into two molecules of pyruvic acid. Thiamin diphosphate serves as a coenzyme in many reactions that occur during glycolysis. The pyruvate generated will enter the Krebs cycle, where thiamin catalyzes the breakdown of fatty acids, carbs, and proteins to make ATP. Orchids utilize ATP to facilitate their vegetative growth. Based on the findings of [5], the utilization of Thiamin at a concentration of 3ml/L yields the best results in terms of leaf length and stem height for *Dendrobium* orchid seedlings following the process of acclimatization. According to [19], thiamine treatment has the potential to enhance the germination and growth of chickpea seedlings. The findings of this study further demonstrate that thiamine can serve as both a growth stimulant and a resistance enhancer in chickpeas. Additionally, a separate study conducted by [20] found that the timing of nutrient solution delivery had an impact on the quantity, length, and width of *Phalaenopsis* leaves.

3.3 Root growth

The variance analysis results indicated that there was no significant interaction between the type of medium and the nutrient supply on the parameters of root number, root length, and root diameter of *Vanda tricolor* 8 weeks after planting. This indicates that there is no reciprocal impact between the medium type and the nutrient source on the growth of *Vanda tricolor* roots. Figure 4 indicates that the kind of medium does not affect the parameters of root number, root length, and root diameter of *Vanda tricolor*. Nevertheless, the utilization of lumber as a growth medium for *Vanda tricolor* promotes a more significant increase in

root quantity, root length, and root diameter compared to the combination of lumber, coconut husk, and moss as a growth medium. The roots of the orchid utilize water and nutrients from the lumber medium, which allows the cells to divide and promotes development in the quantity, length, and diameter of the roots, like how leaf growth occurs. The coconut husk possesses the capacity to retain water and includes essential macronutrients like nitrogen (N), phosphorus (P), and potassium (K) [21], which can promote the growth of plant roots. Nevertheless, the use of coconut husk as a substrate, in conjunction with lumber and moss, did not yield superior development compared to employing lumber as the only medium. This phenomenon can be attributed to the microclimate settings being somewhat humid, allowing the lumber medium, which has a lower capacity to retain water, to nevertheless supply the necessary moisture for plant growth.

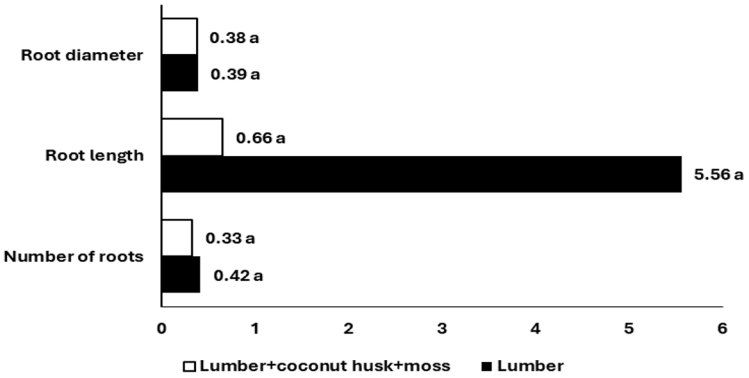

Fig. 4. Effect of medium type on number of roots, root length and root diameter of *Vanda tricolor* seedlings 8 weeks after planting.

Figure 5 indicates that the nitrogen source treatment did not have a significant effect on the root number, root length, and root diameter parameters of *Vanda tricolor* after 8 weeks of planting. Nutritional treatment with Vitamin B1 leads to an increase in root diameter. The reason for this is that Vitamin B1 can expedite cell division and enhance hormone activity in plants, thus promoting the formation of new cells and serving as coenzymes in glucose metabolism [22]. Irrigation alone tends to promote a proliferation in the quantity and elongation of the roots. The roots receive water directly, allowing the cells to immediately absorb the water and promote the elongation of root cells [23]. In addition, an adequate amount of water stimulates the development of secondary roots in the primary roots of *Vanda tricolor*.

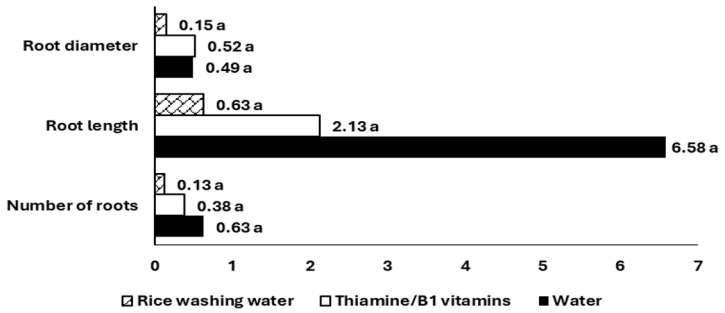

Fig. 5. Effect of nutritional sources on the number of roots, root length and root diameter of *Vanda tricolor* seedlings 8 weeks after planting.

4 Conclusions

1. The growth of *Vanda tricolor* following acclimatization is influenced by both the kind of medium and nutritional source, specifically by disease attack factors.
2. The optimal medium for promoting the growth of *Vanda tricolor* following acclimatization on the slopes of Mount Merapi is lumber.
3. The optimal nutritional supplement to enhance the growth of *Vanda tricolor* following acclimatization on the slopes of Mount Merapi is Vitamin B1.

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